

BROOKHAVEN NATIONAL LABORATORY—USING LIGHT BEAMS FOR ADVANCED COAL AND ASH ANALYSIS

Project Description

Scientists at the Brookhaven National Laboratory are breaking new ground in the fundamental understanding of coal combustion, in an effort to help designers of power plants produce cleaner, more efficient power from coal.

The Brookhaven team is using state-of-the-art analytical equipment at its National Synchrotron Light Source to measure the inorganic matter in coal and coal ash. During the combustion process, this material is transformed into ash particles or molten slag, depending on furnace temperature and the makeup of the mineral matter.

If uncontrolled, ash or slag can cause operational problems in the boilers used today to generate most of the Nation’s electricity. Ash that collects on boiler tubes and slag that deposits on furnace walls and tubes lower the efficiency of heat transfer. Solid ash particles carried by hot combustion gases can erode sensitive boiler tubes to the point of rupture and plant outage.

Understanding how minerals in coal are transformed into ash will help plant designers devise ways to prevent such problems, thereby improving plant efficiency and lowering electricity costs to consumers.

Brookhaven researchers are exposing coal and ash samples to intense beams of monochromatic light of various wave lengths. By measuring the amount of light transmitted through the sample, they can determine both the species and the amount of mineral matter present.

Until recently, the scientists were forced to work only with post-combustion samples brought from power plants and laboratories around the country. Now, a small-scale coal combustor installed on the beam-line has allowed the first measurements of mineral composition and transformation during actual combustion.

Program Goal

The Department of Energy’s Advanced Research Programs recognize that first-class fundamental and applied science is essential to the advance of the U.S.’s global industrial competitiveness, clean energy research, national energy security, and environmental quality. There is a continuing need for risk-sharing by the Federal government in developing and demonstrating new, capital-intensive energy technologies.

The Brookhaven project’s detailed measurements of coal and ash have shown how the minerals in raw coal interact to form ash and slag. Such breakthroughs in the understanding of coal combustion will lead to the development of a new generation of cleaner and more efficient coal-based power systems.

PRIMARY PROJECT PARTNER

Brookhaven National Laboratory
Upton, NY

MAIN SITE

Brookhaven National Laboratory
Upton, NY

TOTAL ESTIMATED COST

\$1,600,000

COST SHARING

DOE\$1,600,000

Non-DOE—

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Project Partners

PHYSICAL SCIENCES, INC.
Andover, MA
(subcontractor)

UNIVERSITY OF KENTUCKY
Lexington, KY
(subcontractor)

Project Benefits

The fundamental coal combustion research being conducted at Brookhaven National Laboratory and its National Synchrotron Light Source will help lay the foundation for more efficient—and less polluting—electricity production from coal now and well into the 21st century.

Today, domestic coal provides the Nation with more than 56% of its supply of electricity. Data from Brookhaven and other related projects are being incorporated into computer models that will be able to predict ash transformation and behavior in coal furnaces. With these tools, plant operators will be better able to avoid operating problems—such as slagging and fouling—that reduce boiler efficiency and raise costs for consumers.

The data will also be useful when some power plants switch to low-sulfur coals to meet standards set by the 1990 Clean Air Act Amendments.

The designers of a new generation of power plants will avoid ash-related problems by using these same data. Forecasts show that America's abundant supplies of coal will remain the dominant source of fuel for power generation well into the next century. At the same time, heightened concerns about coal's impact on the environment will require innovations in pollution controls for newly constructed coal-fired power plants.

A new generation of coal-based power systems, being developed by the Department of Energy's Office of Fossil Energy, will be significantly cleaner and more efficient than today's technology permits. But higher thermal efficiency in electric power generation can require combustion and heat transfer at temperatures significantly higher than today's systems attain. Some high-temperature materials that can withstand those conditions, such as advanced alloys and ceramics, are generally intolerant of coal ash. Knowing the detailed makeup of ash products will help in the design of advanced materials that can withstand the ash.

The fundamental knowledge of ash transformation being acquired through the Brookhaven studies will improve the performance of coal-fired power plants, boosting plant efficiency and lowering electricity costs for consumers.

Cost Profile (Dollars in Thousands)

	Prior Investment	FY95	FY96	FY97	Future Funds
Department of Energy *	\$1,100	\$160	\$150	\$170	—
Private Sector Partners	—	—	—	—	—

* Appropriated Funding

Key Milestones

FY88	FY89	FY90	FY91	FY92	FY93	FY94	FY95	FY96	FY97
Upgrading & Analysis				Construction		Analysis			
Upgrading of synchrotron beamline; quenched sample analysis				Construction and installation of <i>in-situ</i> combustion cell		Analysis of slag compounds		Analysis of trace toxic compounds	